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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Adjustable Chair

(72) Eakins, Richard - Canada ;
Cimachowski, Czeslaw - Canada ;
Bentley, Brian - Canada ;
Krommenhoek, Joe - Canada ;
Ma, Son - Canada ;
Harding, David - Canada ;
Pang, Nelson - Canada ;

(73) Same as inventor

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Notice: The specification contained herein as filed

The present invention relates to adjustable chairs.

A common type of adjustable chair is the motorized wheel chairs, which have helped make the life of a handicapped person more comfortable and more independent. Motorized wheel chairs generally have a seat frame and a back frame, both of which are adjustable relative to a base frame. A back support is usually provided on the back frame to receive the trunk of the user. In some cases, the back support is movable relative to the back frame. The adjustment of these components is made possible by what is referred to in the art as 'tilt', 'recline' and 'zero-shear' mechanisms. Several terms relating to these mechanisms and used commonly amongst those skilled in the art are as follows:

'Tilt' refers to a change in angle of the seat frame relative to the wheel chair frame, while the angle of the back frame relative to the seat frame stays constant.

'Recline' refers to a change in the angle of the back frame relative to the seat frame. In this case, the angle of the back frame relative to the seat frame increases or decreases to the desired back frame position while the seat frame angle relative to the wheel chair frame stays constant.

'Shearing' refers to the shear or tangential forces that occur as a result of the relative displacement between the user's trunk and the back support. This occurs because the center of rotation of the user's trunk (approximately located at the user's hip joint) does not coincide with the axis of rotation of the back frame. Shearing is a problem because it can cause decubitus ulcers (pressure sores) on the user's body and because it creates problems in maintaining the correct position of the posutural supports (eg. chest pads, headrests) and control devices (eg. chin control systems) relative to the user.

'Zero-Shear' is an industry used term that refers to a reclining back system that uses a mechanism which significantly reduces (but not necessarily completely) eliminates the effects of shear. Because the back support moves with the user, postural support and control devices are often attached to the back support to maintain correct positioning of these devices relative to the user.

Typically, zero-shear systems utilize a sliding back support that is either attached to the back frame with glide blocks or rollers. Sliding back supports are usually actuated with mechanical linkages, cam or cable systems and which travel at a fixed speed relative to the rotation of the back frame. The conventional devices have been found to be unsatisfactory, since they fail to take into account the specific needs of each user, which tend to change from one user to another.

Conventional motorized wheel chairs have also been outfitted with 'anti-tipping' wheels emerging from the chair to support the chair from overturning. However, there are some instances where conventional 'anti-tipping' wheels fail to prevent overturning because they fail to take into account that the centre of gravity of the user may shift as the chair is adjusted.

It is therefore an object of the present invention to obviate or mitigate the above mentioned disadvantages.

Briefly stated, the invention involves a chair comprising a base frame and a back frame, means for rotating said back frame relative to said base frame, said back frame including a back support to receive a trunk portion of a user, means for displacing said back support relative to said back frame, a control unit communicating with said means for rotating and said means for displacing, said control unit having adjustment means to vary the displacement of said back support according to the rotation of said back frame inorder to minimize shear forces appearing between said trunk and said back support.

In another aspect of the present invention, there is provided a chair of the type having a base frame, a back frame movable relative to said base frame and a wheel assembly to roll along a floor surface, said chair comprising anti-tipping means for reducing the risk of the chair tipping over, said anti-tipping means including a support element mounted on a lower

portion of said base frame and arranged to contact said floor surface upon tipping of said chair, said support element being movable between a position near said wheel assembly and a position relatively remote therefrom, displacement means for displacing said support element between said positions, said displacement means being responsive to changes in orientation of said back frame relative to said base frame, said anti-tipping means being responsive to changes in position of a centre of gravity of said user so as to displace said support element rearwardly to one position when said centre of gravity is shifted rearwardly and to displace said support element forwardly to another position when said centre of gravity is shifted forwardly.

In yet another aspect of the present invention, there is provided a chair comprising a base frame and a back frame, means for rotating said back frame relative to said base frame, said back frame including a back support to receive a trunk portion of a user, linkage means for displacing said back support relative to said back frame, said linkage means including a pair of parallel links pivotally connected at one end to a corresponding pair of locations on said seat frame, said parallel links being pivotally coupled at an opposite end to a corresponding pair of locations on a third link, one of said locations being adjustable relative to said third link, said third link being pivotally connected at a third location to said back support, whereby said linkage means causes said back support to displace upon rotation of said back frame, the displacement of said back support being

adjustable by adjusting said one location.

In yet another aspect of the present invention, there is provided a method of adjusting a chair comprising the steps of:

providing a base frame, a back frame and a means for rotating said back frame relative to said base frame,

providing on said said back frame, a back support to receive a trunk portion of a user,

providing a means for displacing said back support relative to said back frame,

providing a control unit communicating with said means for rotating and said means for displacing,

providing on said control unit adjustment means to vary the displacement of said back support according to the rotation of said back frame inorder to minimize shear forces appearing between said trunk and said back support.

In still another aspect of the present invention, there is provided a method of reducing the risk of a chair overturning, comprising the steps of:

providing a chair of the type having a base frame, a back frame movable relative to said base frame and a wheel assembly to

roll along a floor surface,

mounting a support element on a lower portion of said base frame and arranging said support element to contact said floor surface when the chair overturns,

displacing said support element between a position near said wheel assembly and a position relatively remote therefrom, in response to changes in orientation of said back frame relative to said base frame, thereby in response to changes in position of a centre of gravity of said user so as to displace said support element rearwardly to one position when said centre of gravity is shifted rearwardly and to displace said support element forwardly to another position when said centre of gravity is shifted forwardly.

In still another aspect of the present invention, there is provided a method of adjusting a chair comprising the steps of:

providing a chair with a base frame, a back frame and means for rotating said back frame relative to said base frame,

providing a back support on said back frame to receive a trunk portion of a user,

providing linkage means for displacing said back support relative to said back frame, including a pair of parallel links pivotally connected at one end to a corresponding pair of locations on said seat frame,

pivotally coupling said parallel links at an opposite end to a corresponding pair of locations on a third link,

arranging one of said locations to be adjustable relative to said third link,

pivotally connecting said third link at a third location to said back support, whereby said linkage means causes said back support to displace upon rotation of said back frame, the displacement of said back support being adjustable by adjusting said one location.

Several embodiments are illustrated by way of example only in the appended drawings, in which:

Figure 1 is an exploded perspective view of a motorized wheel chair;

Figure 2 is a sectional view taken on line 2-2 of figure 1;

Figure 3 is fragmentary side view of one portion of the wheel chair illustrated in figure 1;

Figure 4 is a schematic view of another portion of the wheel chair illustrated in figure 1;

Figures 5a) to d) are schematic views of another portion of the wheel chair illustrated in figure 1;

Figure 6 is a graph corresponding to figures 5a to d;

Figures 7a) to d) are shematic side views of the wheel chair illustrated in figure 1;

Figure 8 is a graph corresponding to figures 7a) to d);

Figure 9 is a fragmentary perspective view of a portion of an alternative wheel chair; and

Figure 10 is a perspective view of one component illustrated in figure 9.

Referring to the figures, there is provided a motorized wheel chair 10, having a base frame 14. A back frame 18 and a seat frame 20 are pivotally coupled to the base frame 14. The seat frame carries seat support 20a. A back support 21 is mounted on the back frame 18 for displacement relative thereto and is arranged to receive the trunk portion of a user (not shown). There is provided a means of rotating the seat frame 20 relative to the base frame 14 in the form of a tilt actuator 22, a means of rotating rotating the back frame 18 relative to the base frame 14 in the form of a recline actuator 24 and a means of displacing the back support 21 relative to the back frame 18, in the form of a zero-shear actuator 26. The linear actuator is known and thus will not be discussed further. The base frame 14 supports a drive train driving a wheel assembly, the rear wheels of the wheel assembly being shown schematically in figures 3 and

7a) to d). The rear wheels have an axis of rotation identified by line 27.

An anti-tipping mechanism 28 is also provided on a lower portion of the base frame 14 and includes a pair of support elements in the form of wheels 30. The wheels are arranged to contact the floor surface upon tipping of the chair. Line 31 in figure 3 illustrates the floor surface contacting the wheel 30 when the chair is tipped rearwardly. As will be described, the wheels 30 are movable between a position near said wheel assembly and a position relatively remote therefrom and is responsive to changes in orientation of said back frame 18 relative to the base frame 14. In this manner, the anti-tipping mechanism 28 is responsive to changes in position of a centre of gravity of the user so as to place the wheels 30 at the remote position when the centre of gravity is shifted rearwardly and to place the wheels at the near position when the centre of gravity is shifted forwardly.

The base frame 14 has upper and lower longitudinal members 14a and 14b on both the left and right hand sides as viewed by the user. Front and rear uprights 14c, 14d on both sides are joined to the longitudinal members as are upper and lower transverse members, 14e and 14f, the transverse members 14f arranged to carry a battery pack (not shown).

A base frame extension 32 is provided on each side of the chair 10 immediately aft of the corresponding rear upright 14d

and carries the anti-tipping mechanism 28 as will be discussed.

The seat frame 20 includes a pair of longitudinal members 20a and a pair of transverse members 20b. A pair of pivot couplings 34 are provided at each of the rear corners of the seat frame 20 to pivot the seat frame 20 to the base frame 14. A pair of arm supports 20c extend upwardly from both longitudinal members 20a and each carry an arm pad 36. The left hand arm support 20c also carries a control unit 38. The front transverse member 20b has a mounting flange which carries one end of the tilt actuator 22.

The back frame 18 includes a pair of uprights 18a joined to an upper transverse member 18b. A pivot coupling 39 is provided between the lower end of each upright 18a and the rear end of each longitudinal member 20a of the seat frame 20 to permit the back frame 18 to pivot relative to the seat frame 20. Four sliding blocks 42 are slidably mounted on the uprights 18a and in turn are fixed to a respective corner of a the back support 21.

The upper transverse member 18b serves as an anchor for one end of both the recline and zero-shear actuators 24 and 26. The other end of the zero shear actuator is pivotally coupled to a flange 44 emerging from the lower portion of the back support 21, while the opposite end of the recline actuator 24 is mounted on the rear transverse member 20b of the seat frame 20.

Each upright 18a of the back frame 18 is also provided with

an anchor flange 46 to receive one end of a cable 48, the opposite end of which is secured to another anchor flange 50 on the anti-tipping mechanism 28. The cable 48 is further supported by a mount 51 on the corner of the base frame extension 32 and a mount 53 on the lower longitudinal member 14b. For the sake of simplicity, only one anti-tipping mechanism 28 is illustrated in detail in the figures.

As will be described, the control unit 38 functions to vary the displacement of the back support 21 according to the rotation of the back frame 18 inorder to minimize shear forces appearing between the user's trunk and the back support 21. The control unit 38 is schematically illustrated in figure 4 and enables the user to adjust the tilt, recline and zero-shear actuators 22, 24 and 26 respectively. The control unit 38 has a number of toggle switches 40a to 40d which convey a signal to relays 42a to 42d respectively. Toggle 40a is also coupled to relay 42b by way of conductor 41 to permit toggle 40a to activate relays 42a and 42 at the same time. Each of the relays 42a to 42d has an output coupled to an exterior device, such as recline, zero-shear and tilt actuators 22, 24, 26 or to an auxiliary device as is shown at 46, for example a power leg lift actuator.

Located on the output of relay 42b are a pair of potentiometers 44a, 44b which are used to vary the power delivered to the zero shear actuator 26 as will be described.

The toggles and relays are arranged in such a way that the actuators may be powered in two different directions, that is in an upward and downward direction by using the same toggle activated in the same direction. Of course, other switching arrangements may be used to activate the relays, including an interface with a directional controller found on some motorized motorized wheel chairs.

A particular feature of the control unit 38 is the ability to calibrate the chair so that the displacement of the zero-shear actuator may be optimized for the particular needs of each user in a simple and economic manner. This is done by controlling the relative displacement of the zero-shear actuators 26 relative to the recline actuator 24 through adjusting the potentiometers 44a, 44b, which inturn varies the amount of power being delivered to the zero-shear actuator in the inward direction (that is toward the pivot coupling 39) and outward direction. The two potentiometers are of the type having a diode configuration as is known in the art and allow the speed of the zero-shear actuator in the inward direction to be adjusted independently of the speed in the outward direction. This enables the user to compensate for the effects of gravity by providing an increased amount of power to the zero-shear actuator in the outward direction. Without this compensation, the zero-shear actuator would tend to travel faster in the inward direction.

Thus, as the back frame 18 reclines, the back support 21 slides inwardly toward the pivot couplings 39. Shearing is

significantly reduced because the back support 21, in effect, stays in contact with the user's trunk with little or no relative movement. With the toggle 40b, the user may adjust the zero-shear actuator independently of the recline actuator.

For example, one user may need to have the back support 21 move two only inches during the full downward rotation of the back frame 18. In this case, the potentiometer is adjusted so that only that amount of power is delivered to the zero-shear actuator to cause it to displace the back support 21 at a speed resulting in two inches of travel in the time it takes to rotate the back between the fully upright position (as shown for example figure 5a) and fully reclined position (as shown in figure 5b). This situation is illustrated in figure 6 wherein the dashed line represents two inches in a fully reclined position

Similarly, another user may need to have the back support 21 travel seven inches between the fully upright and fully reclined positions of the back frame 18. Accordingly, the potentiometer is be set to deliver a correspondingly higher amount of power to the zero shear actuator. This example is illustrated by the chain-dot line in figure 6.

Once the desirable potentiometer adjustments have been made, the user merely has to operate toggle 40a, causing the zero shear actuator to displace the back support 21 while the back frame 18 is being reclined. Another toggle in the same direction causes the polarity of the power delivered to the recline and

zero-shear relays to be reversed causing the back frame 18 to be returned to its fully upright position.

While the back frame 18 is reclining relative to the base frame 14, the cable 48 is displaced causing the anti-tipping mechanism 28 to extend the wheel 30 outward. In this economical manner, the anti-tipping mechanism 28 need not be separately controlled by the control unit 38.

The anti-tipping mechanism 28 includes an outer tube member 28a telescopingly engaged with the rear section of a corresponding lower longitudinal member 14b and is outwardly spring biased by a compression spring shown at 52. Mounted on the remote end of each outer tube member 28 is one of the wheels 30. As can be seen by figure 3, the wheels 30 are spaced from the floor surface a sufficient distance to avoid obstacles while being close enough to the floor surface to provide support should the wheel chair tip rearwardly.

A particular feature of the anti-tipping mechanism 28 is that the wheel 30 is in an operative position through its full displacement. In addition, the anti-tipping device is arranged so that the location of the wheel 30 changes with changes in the position of the back frame 18 (as illustrated, for example, at 18, 18' and 18") relative to the base frame 14 of the chair. This ensures that the location of the wheel 30 varies with any shift of the user's centre of gravity. This relationship is illustrated in figures 7a) to d). As the back frame 18 rotates

downwardly, the centre of gravity, as represented by the vector 'CG' shifts rearwardly, that is, to the right as viewed in the figures 7a) to d). In turn, the wheel 30 is displaced rearwardly.

It will be seen that the displacement of the wheel 30 is a function of the following variables:

i) the length of the cable 48;

ii)the locations of the flanges 46, 50 and mounts 51, 53; and

iii)the locations of the pivot couplings 34 and 39.

Accordingly, the displacement of the wheel relative to the back frame may be adjusted if desired by altering these variables.

When the back frame 18 is returned to its full upright position, the wheel 30 is retracted. Thus, the anti-tipping mechanism 28 maintains the user's support through all back frame 18 inclinations, while improving manoeverablity by keeping the wheels 30 out of the way when the user's centre of gravity is not in a position requiring the wheels to be remotely located.

Another advantage of the spring biased anti-tipping mechanisms 28 is that, in a most situations, the outer tube member 28a is only partially telescoped with the rear section of the lower longitudinal member 14b, which means that the wheels 30 will spring inwardly should they make contact with walls, doors

and the like, thereby reducing damage. As soon as the wheel 30 moves away from the obstacle, it returns to its appropriate position, which would be sufficient to prevent the chair from tippng over in normal situations.

Should the cable 48 break, the outward spring biased wheel 30 immediately springs to the fully extended position, thereby ensuring that the user's safety is maintained. Of course, the outwardly biasing spring could be replaced by some other biasing member or could perhaps be integrated into the control unit 38 by making use of a linear actuator to displace the wheel.

In alternative embodiment as shown by figure 7, the zero-shear linear actuator is replaced by a linkage means for displacing said back support relative to the back frame in the form of a multiple link mechanism 80. The mechanism includes a pair of parallel links 82 pivotally connected at one end to a corresponding pair of locations on said seat frame, namely at the coupling flange 84 joining the seat frame 20 to the back frame 18. The opposite ends of the parallel links 82 are pivotally coupled to spaced locations on a third link 86. One of those locations, namely that identified by 88 is characterized by several pivot holes, each of which arranged to receive a pivot pin, not shown. The third link 86 has a third location 90 which is pivotally coupled to the lower block 92 of the back support 21.

The selection of one of three, or more if desired, locations on the third link allows the orientation of the third link to be

changed relative to the parallel link. Any change in the orientation of the third link will cause a corresponding change to the travel of the location 90 and thus to the back support 21 as the back frame 18 is rotated between a fully upright position and a fully reclined position.

In use, the back frame 18 is reclined by the reclining linear actuator, which causes the parallel links 82 to rotate downwardly. As this occurs, the third link 86 rotates causing the 'third' pivot to follow both a downward and outward path. It is this path that can be adjusted by the selection of one of the alternative locations 88, since each location will define a different path to be taken by the third link 86 and thus the back support 21.

If desired, the pivot holes 86a may be replaced by a slot 86d, as illustrated in figure 10, wherein the corresponding parallel link is pivotted to a given location along the slot. The advantage with this arrangement is that the location of the pivot is adjustable along the length of the slot.

While the above discussion has been resticted to wheel chairs, it will of course be recognized that some of the features disclosed may be appilcabe to other support devices, such as dentist chairs.

It should also be recognized that minor variations to the embodiments disclosed therein will not depart from the spirit of

the invention. For example, several alternative arrangments exist for the anti-tipping mechanism shown. The tubes need not telescope relative to one another, provided sufficient support is provided for the wheel to be in an operative position in all positions of the back support 21. The back support 21 may of course be mounted on the uprights in a number of different arrangements, including the use of tracks and the like. While the discussion above has been restricted to the use of wheels 30 in the anti-tipping mechanism, it will of course be understood that other forms of support elements may be used such as downwardly projecting support pegs. In addition, the anti-tippng mechanism may be used to support the chair in other locations, for example, the front or the sides therof. Other means may be employed to displace the support element relative to a given shift of the centre of gravity, including the use of electronic sensors coupled to anti-tipping mechanism in the form of a linear actuator driven support element or the like.

WE CLAIM:

1. A chair comprising a base frame and a back frame, means for rotating said back frame relative to said base frame, said back frame including a back support to receive a trunk portion of a user, means for displacing said back support relative to said back frame, a control unit communicating with said means for rotating and said means for displacing, said control unit having adjustment means to vary the displacement of said back support according to the rotation of said back frame inorder to minimize shear forces appearing between said trunk and said back support.

2. A chair as defined in claim 1 further comprising a seat frame and means for rotating said seat frame relative to said base frame, said control unit communicating with said means for rotating said seat frame.

3. A chair as defined in claim 2 wherein said control unit is accessible to said user to permit said user to make adjustments to the orientation of said back frame, said back support and said seat frame.

4. A chair of the type having a base frame, a back frame movable relative to said base frame and a wheel assembly to roll along a floor surface, said chair comprising anti-tipping means for reducing the risk of the chair tipping over, said anti-tipping means including a support element mounted on a lower portion of said base frame and arranged to contact said floor

surface upon tipping of said chair, said support element being movable between a position near said wheel assembly and a position relatively remote therefrom, displacement means for displacing said support element between said positions, said displacement means being responsive to changes in orientation of said back frame relative to said base frame, said anti-tipping means being responsive to changes in position of a centre of gravity of said user so as to displace said support element rearwardly to one position when said centre of gravity is shifted rearwardly and to displace said support element forwardly to another position when said centre of gravity is shifted forwardly.

5. A chair as defined in claim 4 wherein said displacement means includes a pair of members movable relative to one another, one of said members carrying said support element at a remote end thereof.

6. A chair as defined in claim 5 wherein said one member is outwardlly biased relative to the other member, said diplacement means includes a cable coupled between said one member and said back frame.

7. A chair comprising a base frame and a back frame, means for rotating said back frame relative to said base frame, said back frame including a back support to receive a trunk portion of a user, linkage means for displacing said back support relative to said back frame, said linkage means including a pair of parallel

links pivotally connected at one end to a corresponding pair of locations on said seat frame, said parallel links being pivotally coupled at an opposite end to a corresponding pair of locations on a third link, one of said locations being adjustable relative to said third link, said third link being pivotally connected at a third location to said back support, whereby said linkage means causes said back support to displace upon rotation of said back frame, the displacement of said back support being adjustable by adjusting said one location.

8. A chair as defined in claim 7 wherein said third link has several pivot holes at said one location, wherein said opposite end of one of said parallel links is pivotally coupled to said third link at one of said pivot holes.

9. A chair as defined in claim 7 wherein said third link has a slot at said third location, wherein said opposite end of one of said parallel links is pivotally coupled to said third link at a given position along said slot.

10. A method of adjusting a chair comprising the steps of:

providing a base frame, a back frame and a means for rotating said back frame relative to said base frame,

providing on said said back frame, a back support to receive a trunk portion of a user,

providing a means for displacing said back support relative to said back frame,

providing a control unit communicating with said means for rotating and said means for displacing,

providing on said control unit adjustment means to vary the displacement of said back support according to the rotation of said back frame inorder to minimize shear forces appearing between said trunk and said back support.

11. A method of reducing the risk of a chair overturning, comprising the steps of:

providing a chair of the type having a base frame, a back frame movable relative to said base frame and a wheel assembly to roll along a floor surface,

mounting a support element on a lower portion of said base frame and arranging said support element to contact said floor surface when the chair overturns,

displacing said support element between a position near said wheel assembly and a position relatively remote therefrom, in response to changes in orientation of said back frame relative to said base frame, thereby in response to changes in position of a centre of gravity of said user so as to displace said support element rearwardly to one position when said centre of gravity is

shifted rearwardly and to displace said support element forwardly to another position when said centre of gravity is shifted forwardly.

12. A method of adjusting a chair comprising the steps of:

providing a chair with a base frame, a back frame and means for rotating said back frame relative to said base frame,

providing a back support on said back frame to receive a trunk portion of a user,

providing linkage means for displacing said back support relative to said back frame, including a pair of parallel links pivotally connected at one end to a corresponding pair of locations on said seat frame,

pivotally coupling said parallel links at an opposite end to a corresponding pair of locations on a third link,

arranging one of said locations to be adjustable relative to said third link,

pivotally connecting said third link at a third location to said back support, whereby said linkage means causes said back support to displace upon rotation of said back frame, the displacement of said back support being adjustable by adjusting said one location.

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ABSTRACT

Disclosed herein is a chair comprising a base frame and a back frame, means for rotating said back frame relative to said base frame, said back frame including a back support to receive a trunk portion of a user, means for displacing said back support relative to said back frame, a control unit communicating with said means for rotating and said means for displacing, said control unit having adjustment means to vary the displacement of said back support according to the rotation of said back frame in order to minimize shear forces appearing between said trunk and said back support.

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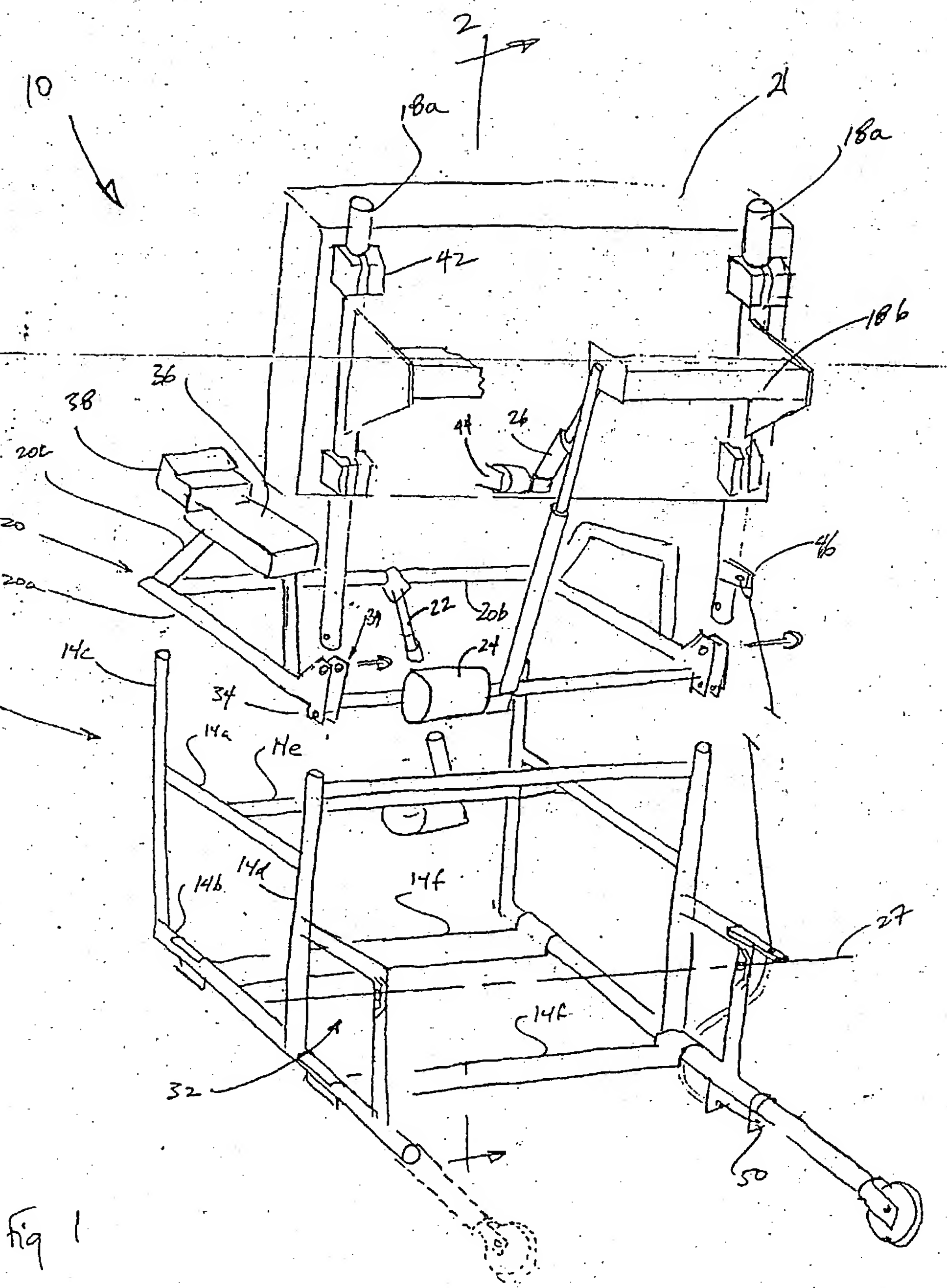

fig 1

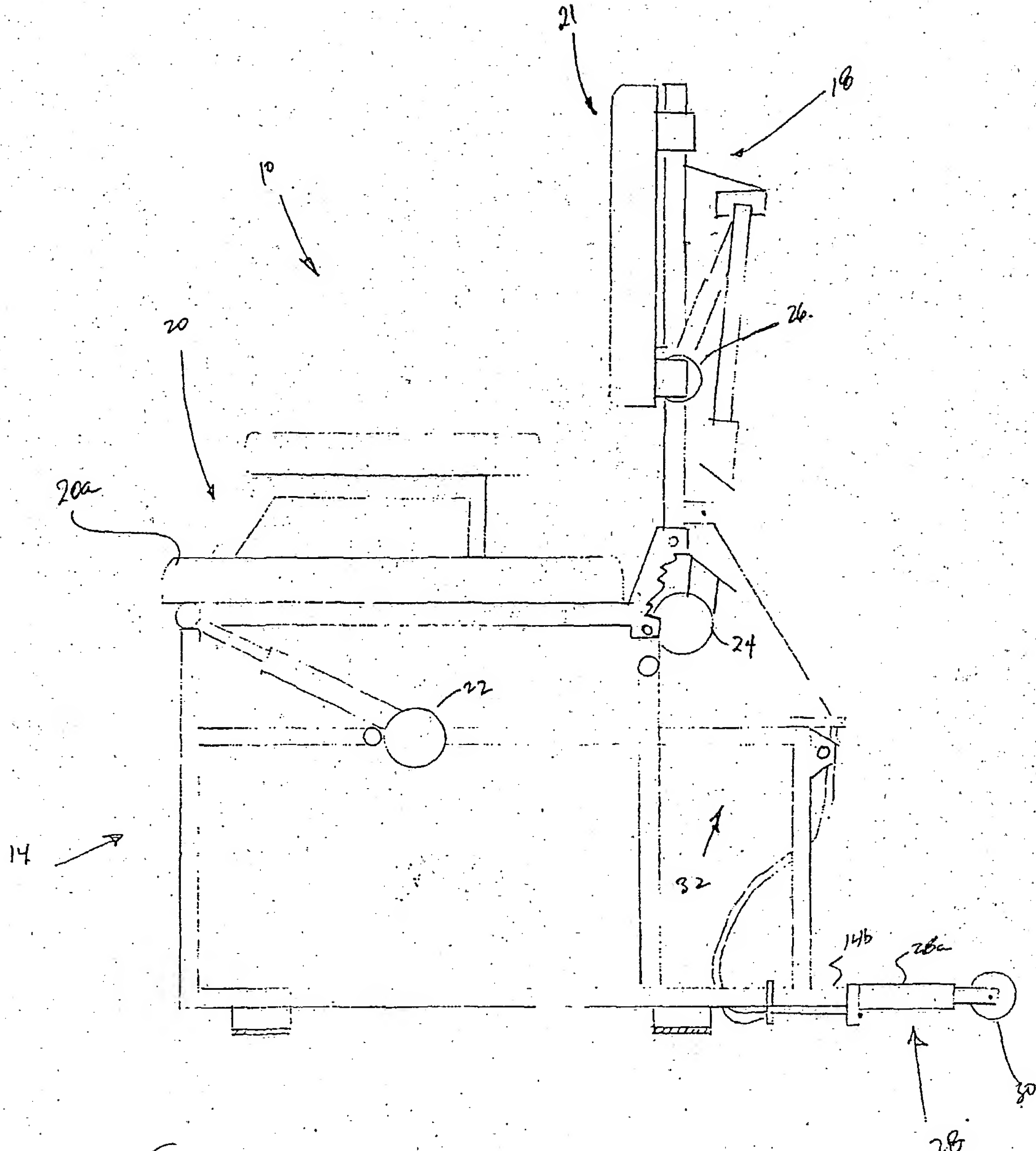

Fig 2

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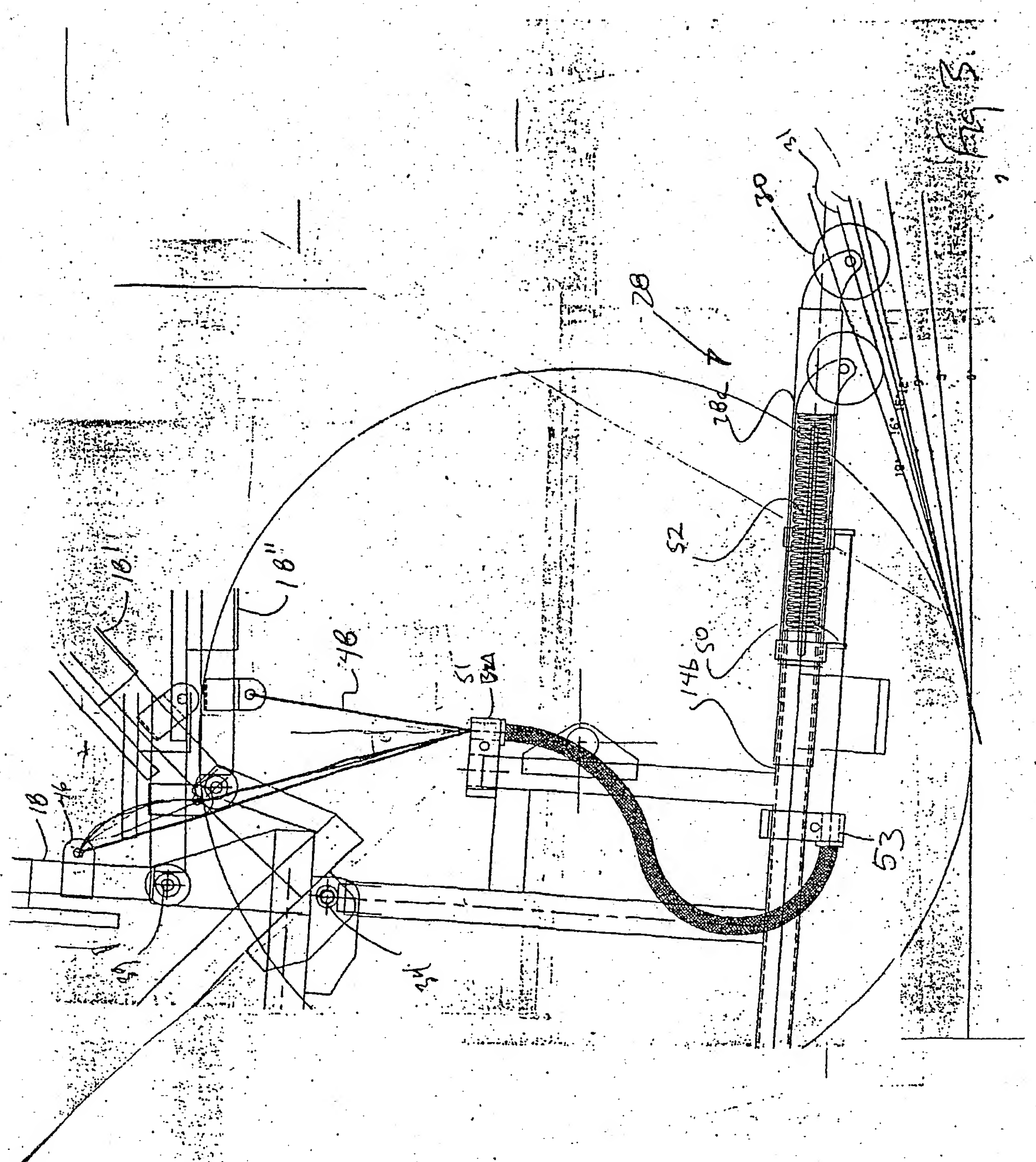

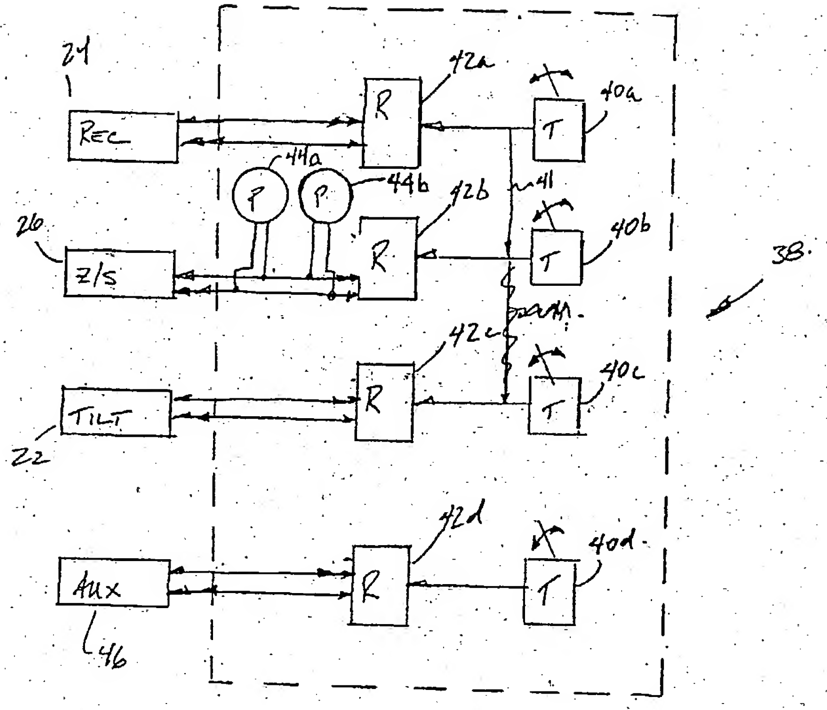
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Fig 4

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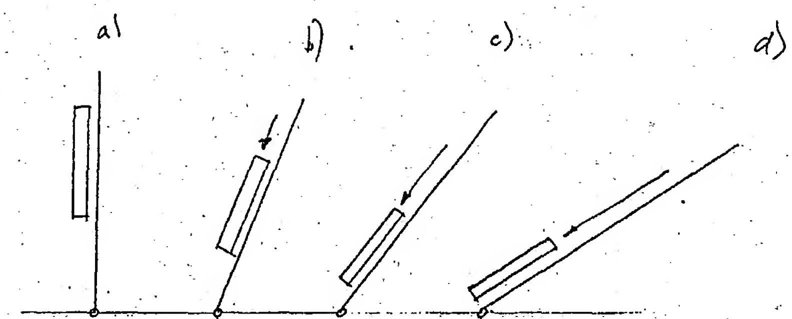

Fig 5

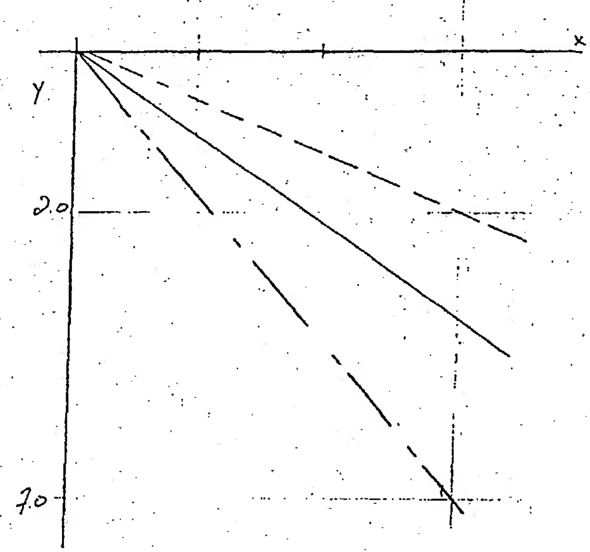

Fig 6.

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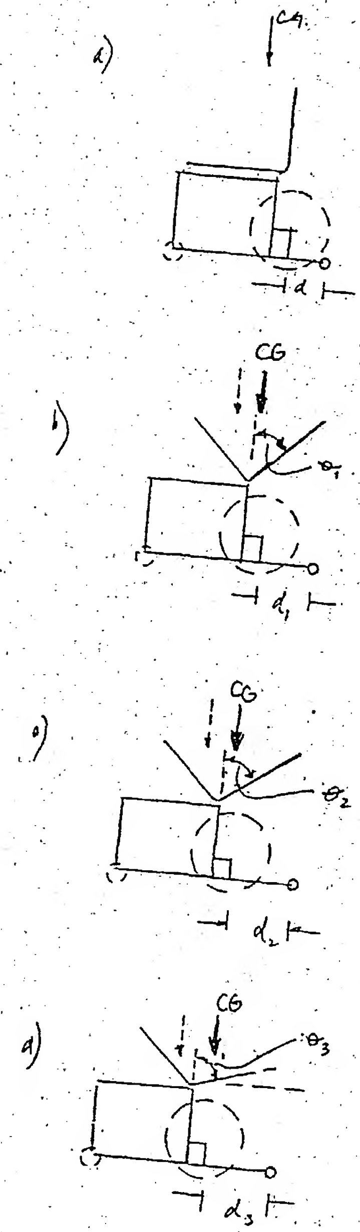

Fig 7

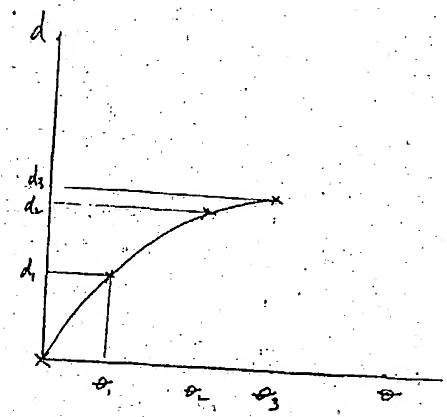

Fig 8.

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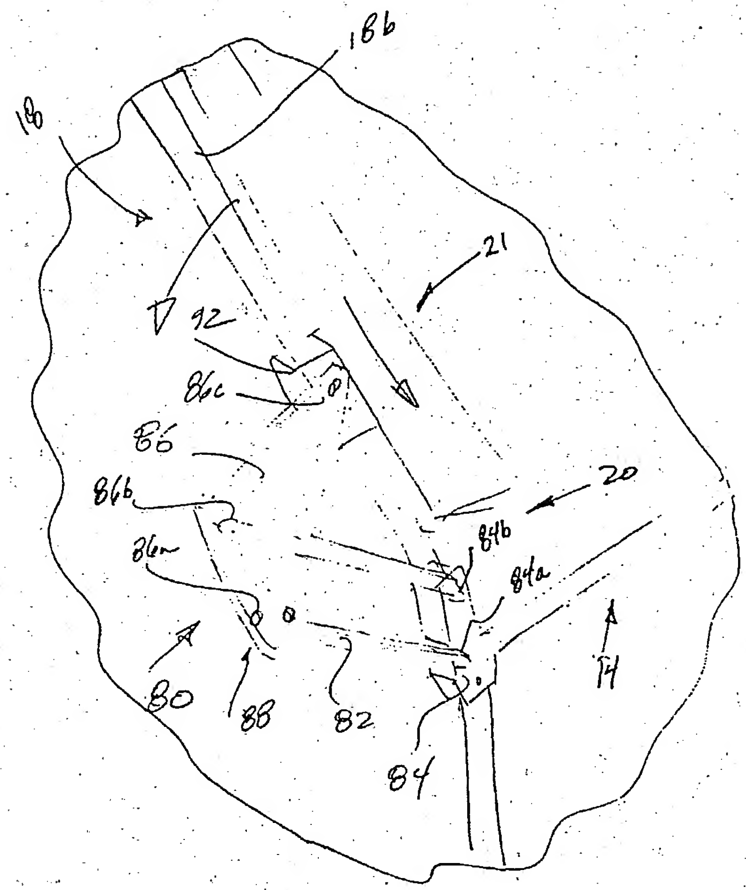

Fig 9

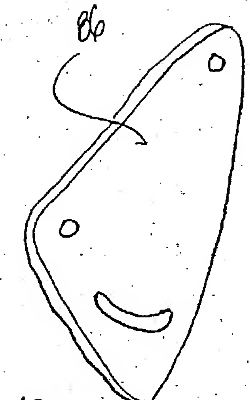

Figure 10